DTU Library

Vertical and horizontal dimensions of upgrading in global value chains: the establishment of local wind turbine component manufacturing in South Africa.

Larsen, Thomas Hebo; Hansen, Ulrich Elmer

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

UNEP DTU PARTNERSHIP

VERTICAL AND HORIZONTAL DIMENSIONS OF UPGRADING IN GLOBAL VALUE CHAINS:

THE ESTABLISHMENT OF LOCAL WIND TURBINE COMPONENT MANUFACTURING IN SOUTH AFRICA

DISCLAIMER

For more on UNEP DTU Partnership;
www.UNEPDTU.org

AUTHORS

Thomas Hebo Larsen

Research Assistant at UNEP DTU Partnership, Department of Management Engineering, Technical University of Denmark, thelar@dtu.dk

Ulrich Elmer Hansen

Senior Researcher at UNEP DTU Partnership, Department of Management Engineering, Technical University of Denmark, uleh@dtu.dk

FORMAT FOR CITATION

Larsen, T., Hansen, U., 2017. Vertical and horizontal dimensions of upgrading in global value chains: the establishment of local wind turbine component manufacturing in South Africa. UNEP DTU Partnership Working Paper Series 2017:2, UNEP DTU Partnership, Technical University of Denmark.

TABLE OF CONTENTS

ABSTRACT

Research on global value chains (GVC) focuses on the vertical dimensions as the main determinants for the insertion and upgrading of suppliers in GVCs. The vertical dimensions include the relationships between buyers and suppliers, the flow of goods and services along the chain and, in particular, the role of lead firms in controlling the governance structure and the barriers to entry for suppliers. This focus on the vertical dimensions greatly overlooks the horizontal dimensions, which might be of equal importance in influencing the conditions for insertion and upgrading in GVCs. The horizontal dimensions include the economic, political and institutional framework conditions around the nodes along the value chain. However, limited research has been conducted focusing specifically on the significance of the horizontal dimensions in relation to the vertical dimensions. To overcome this gap, this paper analyses the role of the state and industrial policy as a key horizontal dimension in the establishment of the local production of key wind turbine components in South Africa. The paper draws on the infant industry literature as a complementary perspective to the GVC framework. We find that the establishment of local production has been limited, which can be explained by means of a framework combining the vertical and horizontal dimensions.

KEY WORDS

global value chains, industrial policy, upgrading, local content requirements, South Africa.

1. INTRODUCTION

An inherent feature of economic globalization is the increasing displacement of production activities across various developed and developing countries. The literature on global value chains (GVC) addresses how this global restructuring of production and trade is organized, focusing specifically on the implications for developing-country firms (Gereffi et al., 2005). The concept of upgrading is used to describe how the competitiveness of developing-country firms may be improved by capturing a higher share of value-added from their insertion and upgrading in GVCs (Humphrey and Schmitz, 2002). The predominant orientation in the literature is the focus on the vertical dimensions that influence prospects for the insertion and upgrading of local suppliers. The vertical dimensions include direct relationships between buyers and suppliers, the movement of goods and services, and the flow of material resources along the value chain. In particular, research on upgrading in GVCs focuses on the role of lead firms in influencing the conditions for upgrading by controlling the flows of information, technology and finance throughout the entire value chain (Gereffi, 1994; Kaplinsky, 2000; Ponte and Ewert, 2009). By coordinating the functional division of labour and the distribution of value-added activities in the value chain, lead firms create governance structures that determine barriers to entry and hence the opportunities local suppliers have to upgrade (Kaplinsky and Morris, 2003).

This prevailing focus on the vertical dimensions in the GVC literature has been criticized for its lack of attention to the horizontal dimensions that are potentially of equal importance in creating the conditions for the insertion and upgrading of local suppliers in GVCs (Bolwig et al., 2010). The horizontal dimensions include the institutional structures, economic and political framework conditions, public and private regulation, physical infrastructures, supporting industries (e.g. transport and finance) and resource endowments surrounding value chain actors and activities (Liu, 2016). Hence, each node along the value chain, from the upstream input suppliers and production nodes to the downstream consumption nodes, are embedded within spatially localised institutional structures and framework conditions that are external to the value chain. While these chain external (horizontal) conditions are overlooked in the GVC literature, potentially they have a significant influence on value-chain governance and processes of upgrading. The focus in this paper on the horizontal dimension of upgrading forms part of a broader call in the literature for a more detailed understanding of the local and context-specific conditions for upgrading, including (i) the role of the state and national policies (Neilson et al., 2014; Curran, 2015), (ii) the spatial embeddedness of domestic firms and industries in regions (Liu, 2016) and (iii) the relationship between GVCs and national innovation systems (Pietrobelli and Rabellotti, 2011; Lema and Rabellotti, 2016).

In this paper we focus on the role of national industrial policy as an important aspect of the horizontal dimension that potentially influences the insertion and upgrading of local suppliers in GVCs. To that end, we draw on the literature on infant industries, which focuses on the importance of industrial policy and the active role of governments and state intervention in promoting the development of domestic industries (Wade, 1988). This horizontal dimension is combined with a conventional GVC perspective that focuses on the vertical dimension to explore the following research question: what is the relative importance of (vertical) value chain conditions and (horizontal) industrial policy for the insertion and upgrading of local suppliers in GVCs? This question is analysed empirically in relation to the establishment of the local production of key wind-turbine components in South Africa.

The creation of a domestic manufacturing base for wind-turbine components has been a strategic priority for the government of South Africa in driving industrialisation and economic development. The domestic wind-turbine industry has therefore been supported by various promotional policies, such as local content requirements (LCRs) and economic incentives provided by the government. This case is therefore well-suited to analysing simultaneously the roles of these horizontal support policies and of vertical conditions in the global wind-turbine value chain for upgrading in GVCs.

The remainder of the paper is organized as follows. The analytical framework is presented in section two, followed by the research methodology in section three. Section four describes the conditions for upgrading in the global wind-turbine industry, while section five presents the industrial policies that have been adopted in South Africa to stimulate the local production of key wind-turbine components. Section six starts by describing the extent to which the local production of these key components has been established before presenting the main findings from an analysis combining the vertical and horizontal dimensions of upgrading to explain the empirical observations. In section seven the implications of the results presented are discussed. Section eight provides the main conclusions drawn in the paper.

2. ANALYTICAL FRAMEWORK

This section will first present the perspective adopted in the paper in order to address the vertical dimension of upgrading in GVCs, which draws on the conventional GVC literature. Then the perspective adopted to address the horizontal dimension of GVC upgrading will be described, drawing on the infant industry literature, and specifically on the role of the state and industrial policy in the establishment of local production and assembly plants.

2.1. VERTICAL DIMENSION: LEAD FIRMS, GOVERNANCE AND UPGRADING IN GLOBAL VALUE CHAINS

The acceleration of economic globalisation means that international production and trade are increasingly being organized around a globally dispersed set of interconnected activities in value chains (UNCTAD, 2013). The GVC literature provides a perspective with which to analyse the full range of activities along the value chain involved in bringing a product or service from its initial conception and production to its end use and beyond (Kaplinsky and Morris, 2003). Particular attention is devoted to understanding how the capabilities and competitiveness of developing-country firms can be improved through their insertion and upgrading in GVCs. The concept of upgrading has been used to describe how firms may shift to more rewarding functional positions in a value chain or make products that have more value-added invested in them and/or can provide better returns (Gereffi, 1999; Gibbon and Ponte, 2005). This understanding draws on Hobday (1995), who describes upgrading in terms of the transition of firms from involvement in the assembly of (imported) inputs to increased local production to the design of products sold under the brand names of other firms and finally to the sale of their own branded products. This suggests firms gradually moving from an initial position of original equipment manufacturers (OEM) to original design manufacturers (ODM) and finally to original brand manufacturers (OBM). Firms that follow this upgrading trajectory by initially starting out as sub-suppliers of parts or sub-systems of other companies' products to eventually developing the skills to manage the design and branding of their own products will be able to capture an increasing share of the value-added in the value chain. Insertion in the value chain as producers of components is therefore considered a critical pre-condition to making further upward progress (Morrison et al., 2008). This upgrading process is shown in Figure 1 below:

FIGURE 1. GVC UPGRADING TRAJECTORY.

ASSEMBLY ↓	The focus is on production alone, often following buyers' specifications and using materials supplied by the buyer .
ORIGINAL EQUIPMENT MANUFACTURE (OEM) ↓	The supplier takes on a broader range of manufacturing functions, possibly including the sourcing of inputs and logistics functions. The buyers is still responsible for design and marketing.
ORIGINAL DESIGN MANUFACTURE (ODM) ↓	In addition to manufacturing, the supplier carries out parts of the design process, possibly in collaboration with the buyer. In the most advanced cases, the buyer merely attaches its own brand, or "badge" to a product designed and made by the supplier .
ORIGINAL BRAND MANUFACTURE (OBM) ↓	The supplier takes on a broader range of manufacturing functions , possibly including the sourcing of inputs and logistics functions. The buyer is still responsible for design and marketing.

Source: Modified from Hobday (1995) and Gereffi (1999).

Gereffi et al. (2005) argue that the prospects of upgrading in GVCs vary according to the type of governance structure within a given value chain, which can be described along a continuum ranging from more or less free market-based transactions to vertically integrated, hierarchical value chains governed by a few lead firms that set the standards throughout the chain. In between these two extremes are three other types of governance structure with varying degrees of explicit coordination and balances of power between actors in the value chain, depending on the specific combination and degree of three constituent elements characterising the value chain in question: (i) the complexity of transactions, (ii) the ability to codify transactions and (iii) the capabilities in the supply base (see Figure 2 below). In a market-like governance structure, suppliers are highly capable, the complexity of the transactions is low and the ability to codify transactions is high, all of which enables one-off transactions with low coordination and power asymmetry between actors. Conversely, in a hierarchical structure the capabilities of suppliers are low, as is the ability to codify the highly complex transactions. Under such conditions, lead firms will tend to integrate production vertically, which implies high degrees of explicit coordination and imbalances of power.

FIGURE 2. GOVERNANCE STRUCTURES OF GLOBAL VALUE CHAINS.

Governance type	Complexity of transactions	Ability to codify transactions	Capabilities in the supply base	Degree of explicit coordination and power asymmetry
Market	Low	High	High	Low ↑ ↓ High
Modular	High	High	High	
Relational	High	Low	High	
Captive	High	High	Low	
Hierarchy	High	Low	Low	

Source: Gereffi et al. (2005).

The GVC literature uses four main types of upgrading, which are considered to differ according to the governance structure of the value chain (Humphrey and Schmitz, 2002). Product upgrading entails moving into the manufacture of more advanced products within the same product line and thus increasing the value-added. Process upgrading refers to the introduction of new techniques or machinery enabling the manufacturing to turn inputs into outputs more efficiently. Functional upgrading involves moving into other activities within the value chain akin to the move from OEM to ODM to OBM described above. Finally, inter-industry upgrading takes place when skills acquired in one industry are transferred and implemented within a different industry. According to Humphrey and Schmitz (2002), product and process upgrading are likely to occur in captive value chains, since the lead firms have an incentive to invest in the capabilities of suppliers to ensure an optimized value chain. However, functional upgrading is very unlikely to occur in such a governance structure, since lead firms try to keep hold of the most value-adding activities of the value chain (Pietrobelli and Rabellotti, 2011). Functional upgrading is more likely to occur in a relational governance structure, since in this case actors engage with each other on a more level playing field and have a mutual interest in improving their capabilities due to their reciprocal relationship (Navas-Alemán, 2010). One condition for being a part of a relational governance structure is a high capability level among suppliers, which is why developing-country suppliers rarely manage to position themselves in these relationships with lead firms. The prospects for upgrading in modular governance structures are clear, since lead firms do not have an incentive to invest in the capabilities of suppliers, but on the other hand they do not have sufficient coordination to inhibit upgrading either. Hence, upgrading can occur, but at a far slower pace compared to upgrading in captive value chains.

2.2. HORIZONTAL DIMENSION: NATIONAL INDUSTRIAL POLICY AND THE ROLE OF THE STATE IN INDUSTRY FORMATION

The conventional or orthodox view of industrial policy as adopted by the World Bank and promoters of the Washington Consensus generally prescribes a 'hands-off' approach to industrial development in which the role of the state is confined mainly to correcting market failures (Bretton Woods Project, 2012). According to this view, the state should focus mainly on providing basic infrastructural services and the physical and human resources needed to create an equal playing field for the creation and development of new industries. Industrial policy therefore becomes largely a question of enabling markets to function optimally, for example, by implementing structural reforms aimed at liberalising trade, whereby normal market selection pressures will provide the basis for the emergence and survival of the most competitive firms and industries (Babb, 2013). This understanding of the role of the state and industrial policy in correcting market failures contrasts with a view that focuses on the active role of the state and industrial policy in promoting industrial development. This view builds upon research conducted on the remarkable economic development of post-war Japan and the newly industrialising countries of East Asia since the 1980s and 1990s (Amsden, 1989; Hobday, 1995; Kim and Nelson, 2000; Kim, 1997; Mathews and Cho, 1999). This line of research has repeatedly emphasised the importance of industrial policy by highlighting the highly interventionist role of the 'developmental state' in orchestrating the development of domestic infant industries through the use of various carrots and sticks (Freeman, 1988; Wade, 1988). The emphasis on the active role of the state in industrial development is encapsulated by Altenburg (2011;83), who argue that *"the question is thus not whether industrial policies should be adopted or not, but how they can be implemented more effectively".* As shown in Table 1 below, a set of conditions can be drawn from the literature that have been found conducive for achieving rapid and advanced levels of industrial development across a number of countries and industries in Asia. In this paper, we draw on this literature to focus attention on the specific policies adopted in South Africa in order to promote the local production of key wind turbine components.

TABLE 1. CHARACTERISTIC FEATURES OF THE ROLE OF THE STATE AND INDUSTRIAL POLICY IN ASIA.

Policies were coherent and comprised mutually reinforcing sets of 'carrot and stick' incentives, for example performance based subsidies or sanctions
Policy implementation involved close central co-ordination among different agencies and ministries in charge of different support instruments and functions, e.g., MITI in Japan
The overall orchestration was performed by powerful governments that formulated strong long-term industrialisation strategies that provided overall priorities and consistency
The detailed implementation was undertaken by competent and well-remunerated bureaucracies that maintained close contacts with firms
High degree of co-operation between government bureaucrats and managers of private enterprise was established, involving governments pressing firms to form industry associations and co-operative bodies to coordinate public-private interaction
Withdrawal of industry protection was managed in a gradual fashion. Close consultation and monitoring, together with the strictly conditional terms on which support was provided, were the main mechanisms to ensure that protection would be temporary

Source: Modified from Binz et al. (2017) based on Wade (1988, 1990); Kim (1997); Freeman (1988); Amsden (1989); Cimoli et al. (2009); Yeung (2016).

The specific industrial policy instruments typically used to promote infant industry development include local content requirements (LCRs) and direct government subsidies. However, due to the increase in and expansion of global trade agreements, a number of the industrial policy instruments that were previously in force have now been prohibited under international regulations. The emergence of these trade regulations therefore constitutes a challenge for policy-makers in developing countries in identifying new policies and instruments to promote the development of domestic industries (Wade, 2003). Furthermore, the ongoing globalization of production means that developing countries are becoming increasingly dependent on attracting foreign direct investment (FDI) to promote upgrading either by encouraging the establishment of direct links with multinational companies in GVCs and/or indirectly, by creating opportunities for knowledge and technology spill-overs to domestic industries (Milberg et al., 2014). Given the accelerating pace of technological development globally, developing countries are more than ever faced with the pressure to identify emerging industries that offer opportunities to localize production as a means of facilitating the upgrading of capabilities (Gereffi, 2014). The significance of attracting FDI tends to be exaggerated, however, bringing with it the risk of neglecting the importance of investing in the absorptive capacity of local firms in a way that enables the transfer of skills and knowledge.

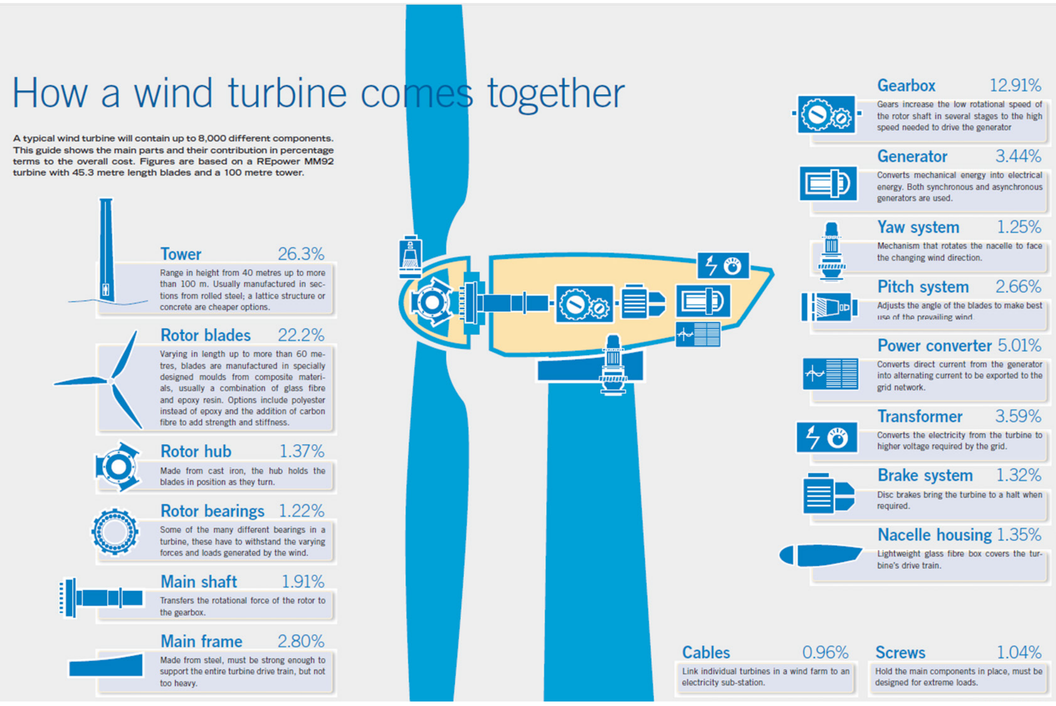
3. RESEARCH METHODOLOGY

This paper relies on a review of a number of documentary sources, including key policy documents, wind industry reports, peer-reviewed journal papers, newspaper articles in the local and international media and firms' records, such as annual reports. To triangulate the data obtained from these sources and to ensure the validity of our findings (Meier et al., 2002), the paper also draws upon eight in-depth, semi-structured interviews conducted with representatives of various organisations in the South African wind turbine industry in 2013 and 2016 (focusing on large-scale wind power projects above 30 MW) (Andersen and Larsen, 2013). The interviewees include representatives of a leading wind power consultancy firm, a blade manufacturer, industry experts and government agencies (see Appendix A for a full list of interviewees). To obtain a detailed understanding of the vertical dimensions of upgrading, the interviewees were asked questions concerning the prevailing conditions in the global wind turbine industry and their possible implications for the establishment of local wind turbine component production in South Africa. To acquire data on the horizontal dimension of upgrading, interviewees were asked to elaborate on the role of the state and industrial policy in influencing the conditions encouraging the local production of wind turbine components. All the interviews were recorded and transcribed to enable subsequent analysis. Data-coding and interpretation procedures followed the tabular approach suggested by Miles and Huberman (1994), which was informed by the analytical framework presented above.

4. GOVERNANCE AND THE PROSPECTS OF UPGRADING IN THE GLOBAL WIND TURBINE VALUE CHAIN

A modern wind turbine works by converting kinetic energy from the wind into electrical power and is thus considered to be a renewable source of energy supplying power to the national grid. The turbine is based on a foundation upon which a tower up to 220 meters high is erected. A so-called nacelle, which is commonly referred to as the ‘brain’ of the turbine, is installed on top of the tower, with a hub placed alongside it to connect the rotor blades to it. While an average wind turbine consists of more than 8,000 components, the three main critical components of wind turbines, which will be the focus of this paper, are (i) the towers, (ii) the rotor blades and (iii) the nacelle components (see Figure 3) (Kierkegaard et al., 2009).

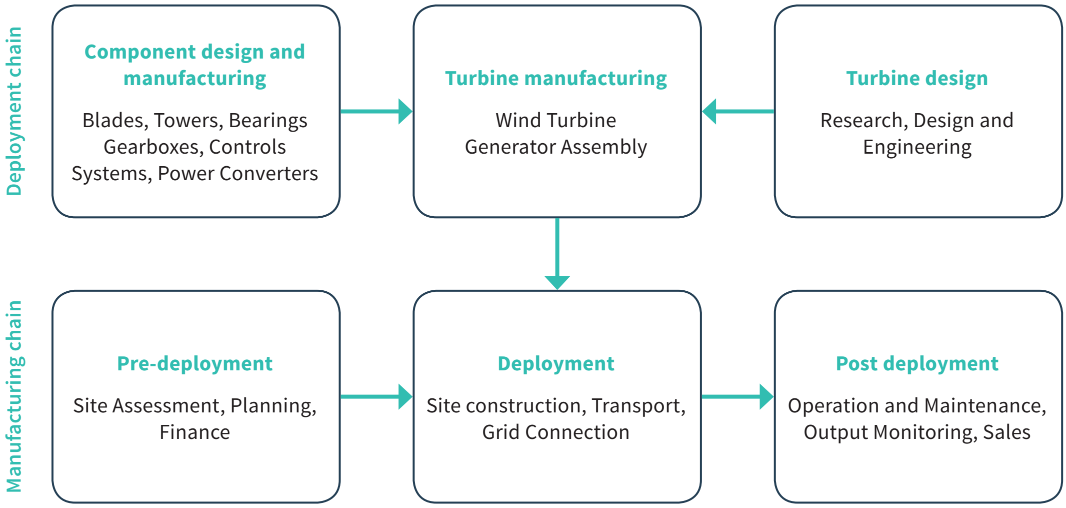
FIGURE 3. KEY WIND TURBINE COMPONENTS.



Source: Blanco (2009).

While a nacelle consists of a number of sub-components, including a gearbox, generator, bearings, converter, transformer and pitch systems, in the following we use 'nacelle components' as an umbrella term. The towers are generally considered to have the lowest technological complexity in a wind turbine, the blades having a somewhat higher technological complexity and the nacelles the highest (Rennkamp and Westin, 2013). The construction of modern wind turbines consists of numerous globally interconnected activities, which, according to Lema et al. (2011), can be divided into two distinct value chains: the manufacturing chain and the deployment chain (Figure 2). Given the focus on the establishment of local wind-turbine component production in this paper (the upper-left box in Figure 4), the following focuses on the manufacturing chain.

FIGURE 4. THE GLOBAL WIND TURBINE MANUFACTURING AND DEPLOYMENT VALUE CHAIN.



Source: Lema et al. (2011).

The global wind turbine industry is among the fastest growing industries globally, with an average annual growth rate of nearly 30% between 2000 and 2010 (Grant Thornton, 2012). This growth has been driven mainly by significant cost reductions and efficiency improvements in the core components, supportive policies and the rising costs of alternative sources of energy, such as oil and diesel. Whereas the demand for wind power until now has mainly been driven by the US and Europe, it is increasingly coming from emerging markets, particularly China and India. The development of an internationally competitive national wind turbine industry has generally relied on a sizeable and stable long-term demand for wind power in the domestic market, in most cases facilitated by an active industrial policy (Lewis and Wiser, 2005). The supply side of the global wind power industry is heavily dominated by lead firm wind turbine manufacturers originating in countries that historically have had the largest markets for wind power, such as the US, Germany, Spain, China and India. The notable exception is Denmark, a pioneer in modern wind turbine manufacturing, which, at a critical stage of industry development, relied on export markets (Garud and Karnøe, 2003). For latecomers to the industry especially, it has proved important to provide a sufficiently large and stable market for wind power in order to attract foreign manufacturers to set up local production as a first step in developing a domestic industry. Publicly funded R&D programs, feed-in tariffs and local content requirements have been among the main support instruments policy-makers across countries have used to stimulate technological development, create a domestic market and thus promote formation of the industry (Lewis, 2011). Furthermore, for more recent entrants to the industry, China and India in particular, more unconventional forms of transferring knowledge have been important in catching up with the frontier (Lema and Lema, 2012). This includes, for instance, R&D partnerships with leading firms and suppliers, as well as the acquisition of foreign firms in industrialized countries.

The global wind turbine value chain resembles a so-called producer-driven chain (Gereffi, 2001), in which lead firms coordinate the production networks of component suppliers, and where competition is mainly based on technological progress through continued R&D. The industry continues to be dominated by a few large lead firms: for example, in 2012, the ten largest wind turbine manufacturers accounted for nearly 80% of the global market (BTM Consult, 2013). The tendency among these lead firms, which include Vestas, Siemens, General Electric, Gamesa, Enercon and Nordex, is to focus their activities increasingly on the parts of the value chain with the highest value-added, such as R&D, engineering and other knowledge-intensive activities (Lema and Lema, 2012). Consequently, lead firms typically retain in-house control of the development and production of key wind turbine components, such as the main control system, the generator and the converter, while the remainder of the up to 8,000 components that a standard turbine consists of are outsourced to an extensive global network of external sub-suppliers. This entails that the manufacturing of such components provides a window of opportunity for the insertion and upgrading of external sub-suppliers in the GVC for wind turbines. However, since a main concern for lead firms is the quality of the outsourced components, they must either rely on established suppliers with proven track records or produce the key components themselves in-house. The established first-tier component suppliers tend to follow the lead firms as they expand into new markets by setting up local production in locations where lucrative and long-term contracts justify the risk of the otherwise large investment costs of establishing new production. This pattern has meant that regional production hubs outside the US and Europe have emerged in markets where the demand for wind power has increased, as in China, and which can serve the demand in surrounding markets (Kierkegaard et al., 2009). Hence, the global wind turbine industry is generally experiencing increasing levels of local production facilities in the form of outsourcing to export markets either to reduce costs or to serve local market demand or both. The interviews conducted for this paper indicated that, for lead firms and first-tier suppliers to establish local production in overseas markets, a minimum of 800-1,000 MW of annually added capacity is required for a prolonged period of time. Another reason that the production of wind turbine components is increasingly moving towards the source of the demand is the high cost of transporting some of the bulkier components, such as towers and blades, which makes these particularly relevant for local production (Schmidt and Huenteler, 2016).

The scale of the wind turbines developed by lead firms has increased significantly over the past forty years. While the capacity of an average wind turbine increased from 75 kW between 1980 and 1990, capacity reached 750 kW in 1995-2000 and 1,800 kW in 2005-2010 (IEA, 2013). This increase in the scale of wind turbines makes transportation of the components increasingly challenging. The tower is the component that is most frequently outsourced for local production, in part due to the transportation costs, but also because of its relative low-tech nature, which means that companies from related heavy machine-manufacturing industries can typically supply this component. As blades require a high level of production capability and specialisation, they are either manufactured in-house at factories owned by the lead firms or outsourced to a few specialized first-tier suppliers. The dominant first-tier supplier of blades is the Danish firm LM Wind Power, whose blades are installed in a third of all installed wind turbines worldwide. The Chinese market for wind turbines, which in 2015 amounted to 33% of total global installed wind power, is dominated by Chinese blade manufacturers (GWEC, 2016). The nacelle components are produced in-house by the lead firms or outsourced to a small group of highly capable external suppliers with a long track-record of providing high-quality components. This entails that the barriers to entry for sub-suppliers to engage in the production of nacelle components for lead firms are high compared to the barriers to manufacturing blades and towers. However, lead firms have begun to outsource the production of some key nacelle components, such as power transformers and smaller bearings, to Chinese sub-suppliers due to the lower costs involved (BTM Consult, 2011).

Following Gereffi et al. (2005), the governance structures of the GVC for wind turbines differ across the key wind turbine components (towers, blades and nacelle components) with regard to the three dimensions of interest: (i) the complexity of transactions, (ii) the codifiability of the transactions and (iii) the capabilities of the suppliers (see Section 2.1. above). Wind turbines may be considered a typical example of a so-called complex-system technology, being characterised by highly customised products that are capital- and engineering-intensive and which require highly specialised knowledge (Huenteler et al., 2016; Schmidt and Huenteler, 2016). Generally, therefore, the complexity of transactions in the wind power industry is relatively high compared, for example, to the mass-produced goods industries (Hobday, 1998). However, when comparing the transaction complexity of wind turbine components, it is clear that the transactions between lead firms and suppliers related to the purchase of towers are less complex compared to blades and nacelle components. In the case of these two components, the lead firms have high and specific requirements for their design and quality, which means that they often produce them in-house. Blades are particularly crucial due to their connection to other components in the turbine and also because they are the most expensive components to repair.

Regarding the codifiability of transactions, towers are easily codified, which means that lead firms often simply provide external suppliers with product specifications and standards that are easily complied with. Hence, both the complexity and codifiability of transactions of towers make this component highly relevant for outsourcing and local production (Elola et al., 2012). Blades, on the other hand, are generally less easily codified, as their development has increasingly become a key parameter whereby lead firms distinguish themselves from their competitors. As much of the R&D effort involved in the development of new blades is tacit in nature, the codifiability of the transactions is equally low. However, the codifiability of a standard blade design is relatively high and therefore it is easy for lead firms to purchase blades from external suppliers. Nonetheless, since lead firms are moving away from standard blade designs, this raises the barriers to entry and, therefore, the prospects for new blade suppliers to enter the industry. The codifiability of nacelle components varies across sub-components, which are easily codified, such as power converters, to components that are very difficult to codify, such as gearboxes.

The level of capabilities in the global supply base of towers is relatively high, as these are simple to manufacture, and competences within related industries are available in many countries globally. This fosters what Gereffi et al. (2005) term a modular relationship between the buyers and suppliers of towers, which is characterized by relatively simple and one-off (market-based) transactions (Pietrobelli and Rabellotti, 2011). Due to the high quality and design requirements, blade production is dominated by a few, highly capable first-tier global suppliers, such as the Danish company LM Wind Power, and in-house production is undertaken by lead firms. The relationship between the first-tier suppliers and the lead firms can be described as relational, as both parties interact closely and on an equal basis. Due to the advanced and specialised production capabilities required, the entry barriers for new entrants to enter into this kind of relationship with lead firms are high. For nacelle components there exist a number of different governance structures, but generally there is a tendency towards a high level of capabilities in the supply base whereby the lead firms rely on long-term relationships with a small group of capable suppliers. There is also a great degree of vertical integration in the production of nacelle components, as the requirements for design and quality are as high and as specific as is the case for blades. Hence, modular, relational and hierarchical governance structures prevail, which present opportunities for new entrants to engage with lead firms in either a modular or captive relationship. This is particularly relevant with regard to nacelle components, with their low level of codifiability.

In summarizing the above, the most conducive conditions for new entrants to insert themselves into the GVC for wind turbines appears to be through the local production of towers, which can serve as a starting point for further upgrading. Towers are costly and bulky and thus difficult to transport from one market to another, and production requires technological skills in areas where many local suppliers have specialised competences. In contrast, the barriers to entry for new entrants to engage in the production of blades are significantly higher due to the quality requirements of the lead firms, which require a considerable level of advanced technological capabilities. Moreover, local production of blades is greatly reliant on the existence of a sizeable and stable market to attract lead firms and/or first-tier suppliers to set up local manufacturing facilities. The prospects of entering the GVC for wind turbines through the local production of nacelle components are low, as these can be easily transported and require a high level of technological skills to meet the high quality requirements of the lead firms. However, for some nacelle components, lead firms have started to emphasize quality less and instead are opting to source these components from Chinese suppliers in order to benefit from significant cost advantages of modular governance structures.

TABLE 2. GOVERNANCE STRUCTURES WITHIN WIND TURBINE COMPONENT VALUE CHAINS.

	Complexity of transactions	Codifiability of transactions	Capabilities in the supply base	Governance
Towers	Low	High	High	• Modular
Blades	High	Low	High/Low	• Relational • Vertical integration
Nacelle components	High	High/low	High	• Relational • Vertical integration • (Modular)

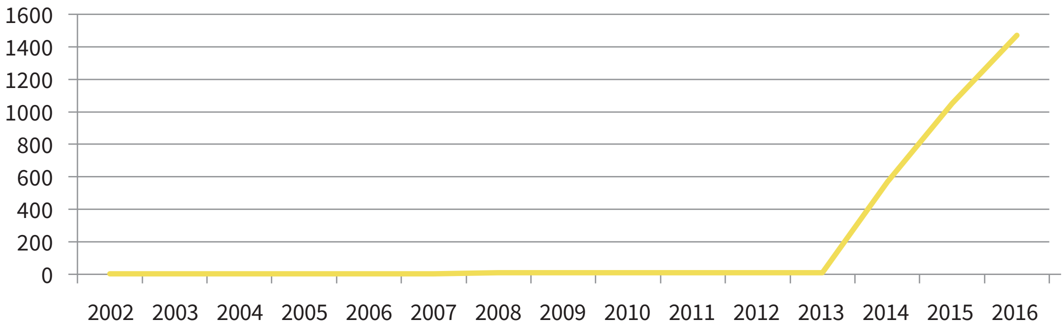
Source: elaborated by the authors.

5. STATE SUPPORT FOR THE ESTABLISHMENT OF LOCAL PRODUCTION OF WIND TURBINE COMPONENTS

Industrial policy in the post-apartheid era in South Africa has largely been focused on supporting the export of goods in traditional labour-intensive, manufacturing industries, such as textiles, garments and the automotive sector (Kaplinsky, 2000). Recently, however, industrial policy in the country has focused to a greater extent on fostering a knowledge-based economy by adopting measures to promote knowledge-intensive industries and to upgrade the human capacity and skills base (Altman and Mayer, 2003; Blankley and Booyens, 2010). This strategy differs from the conventional focus in industrial policy on traditional resources, such as capital and labour, and on the development of the 'production capabilities' needed to produce goods according to existing standards and specifications. The transformation to a knowledge-based economy involves a greater emphasis on the development of 'innovation capabilities' and the manufacture of products with higher value-added content in specific industries (Bell and Pavitt, 1995; IPAP, 2013). This new focus within industrial policy on promoting innovation capabilities in targeted manufacturing industries has been guided by the so-called 'National Industrial Policy Framework' adopted in 2007 and the 'New Growth Path' adopted in 2010 (DTI, 2013a). These overall policies have been followed by more elaborate annual 'Industrial Policy Action Plans' (IPAP), which include more detailed, sector-specific strategies and targets (DTI, 2013b). Renewable energy has been identified in the IPAPs as one of the key prioritised sectors with the potential to contribute significantly to South Africa's transition to a knowledge-based economy. The wind and solar industries have received particular attention as a means of spearheading this transformation, as the government regards them both as technologically advanced and knowledge-intensive industries. Various measures have therefore been adopted to promote the domestic wind and solar industries, including promotional accords signed between the government and representatives of the business community, labour unions and civil society (UNCTAD, 2014). A main objective of the IPAPs has been to support the local production of wind and solar components in South Africa, which could ultimately serve as a manufacturing hub for the regional and global market. The specific measures adopted to this end have included various types of financial support instruments, such as reduced corporation tax rates, and, as described later, designated areas for component manufacturing (DTI, 2015).

The local production of wind turbine components is also being supported by various energy policies adopted in South Africa in which renewable energy has been considered a key part of the ongoing efforts to diversify the energy supply (Rennkamp and Boyd, 2015). In 2003, the government published a 'White Paper on Renewable Energy', which included overall guidelines and strategic objectives for the development of renewable energy in South Africa, covering support for the local manufacture of wind turbine components and demonstration plants (DME, 2003). A number of relatively small wind power projects subsequently emerged, such as the Klipheuwel Wind Farm in 2003 (3.2 MW) and the Darling Wind Farm in the Western Cape in 2008 (5.2 MW) (DTI, 2015). However, in 2010, an 'Integrated Resource Plan' was adopted, which aimed at promoting the development of wind power projects on a significantly larger scale, mainly through a feed-in tariff system providing a fixed and long-term tariff for project developers (DE, 2010). However, the feed-in tariff was later abandoned, as it was found to be in violation of South Africa's procurement laws, and so a tendering scheme was adopted instead. A target was set of added installed capacity of 9,870 MW of wind power to be achieved by 2030. The first 1,850 MW were to be procured through the 'Renewable Energy Independent Power Producer Procurement Programme' (REIPPPP), which was adopted in 2011 and introduced a competitive bidding process for project developers (Eberhard et al., 2014). Figure 5 below shows that the development of wind power projects in South Africa only took off recently as a result of the programme.

FIGURE 5. TOTAL INSTALLED WIND POWER CAPACITY IN SOUTH AFRICA (MW)



Source: Wind Power (2017).

The REIPPPP program includes a number of legal, technical, financial and economic development requirements that bids submitted by project developers were evaluated on the basis of in order to be considered eligible for support under the program. These requirements aim to ensure a number of beneficial socio-economic impacts for South Africa. Projects were, for example, evaluated on the basis of their expected impacts on job creation, local ownership and local content (Department of Energy, 2012). From an industrial policy perspective, the local content requirements (LCR) were particularly interesting, as they were aimed at increasing the degree of local production of wind turbine components used in the wind power projects constructed under the REIPPPP program. The LCR built directly on the policy mentioned above to localise the production of wind turbine components and thus prevent a situation arising in which the wind power projects were based exclusively on imported systems delivered by lead firms on a turnkey basis (DTI, 2010). The degree of local content was intended to increase gradually over time, starting with a minimum threshold of 25% in the first bidding round and reaching 40% in the third bidding round (see Table 3 below). Local content was defined as the costs of the local components and materials used as a percentage of the total construction expenditure of a given project (Brodsky and Matarirano, 2015; DTI, 2015; see also Table 3 below). The main focus in the LCR has been to promote locally manufactured wind-turbine towers, blades and nacelle components, including the input materials required to produce these components, such as steel and aluminium. However, other so-called balance-of-system components have also been accepted, which include civil engineering conducted by local companies and locally sourced building materials (Rennkamp and Boyd, 2015). The three rounds that have already been completed all saw local content reach the stated threshold, though still falling short of reaching the target levels (see Table 3 below).

TABLE 3. EXPECTED AND REALISED LOCAL CONTENT IN WIND POWER PROJECTS UNDER THE REIPPPP PROGRAM.

	First round (2011)			Second round (2012)		
	Threshold	Target	Actual	Threshold	Target	Actual
Local content	25%	45%	27.4%	35%	60%	48.1%
	Third round (2013)			**Fourth round (2015**		
	Threshold	Target	Actual	Threshold	Target	Actual
Local content	40%	65%	46.9%	40%	65%	45%

Source: Eberhard et al. (2014) and Deign (2016).

A total of 1,984 MW was awarded across the rounds, distributed over 32 wind power projects with a combined value of 4,683 million USD (Eberhard et al., 2014). The price of wind energy put forward to project developers decreased by 42% from the first to the third round, mainly due to greater competition between bids in later rounds. Siemens and Vestas, and to a lesser degree ABB and Nordex, were among the main lead firms winning these projects. After the first three rounds, an additional 1,336 MW remains to be awarded, with bidding for the fourth procurement round having been concluded in November 2015 (Rennkamp, 2015). There is general uncertainty regarding how much political commitment there is for the future procurement of wind energy beyond the REIPPPP, since no specific plans have been made to follow up on the initial promise in the Integrated Resource Plan that procurement would continue (Rennkamp, 2015).

6. COMBINING THE VERTICAL AND HORIZONTAL DIMENSIONS TO EXPLAIN THE LOCALISATION OF PRODUCTION

The following will present the key findings on the importance of the vertical and horizontal dimensions in establishing the local production of wind turbine towers, blades and nacelle components respectively.

6.1. LOCAL PRODUCTION OF TOWERS

Three wind turbine tower factories have been established in South Africa so far[1]. The first, called DCD Wind Towers, was set up in 2013 by a local company, DCD Group Ltd., a specialised supplier of heavy engineering and machinery to various sectors, including energy, steel, mining, oil and marine. DCD Wind Towers was created as a separate branch of the energy-related activities of the company. The factory started operations in 2014 and built the first tower in September

1 *It should be noted that another local manufacturer of wind-turbine towers exists in South Africa, called Adventure Power, which produces 300 kW wind turbines (Baker and Sovacool, 2017). These turbines are significantly smaller than the turbines used in the large-scale wind-power projects being constructed in South Africa under the REIPPPP program.*

2014 based on a licensing agreement and design specifications received from the German company Aerodyn Energiesysteme GmbH (henceforward ‘Aerodyn’) (Baker, 2016). While DCD Wind Towers was set up to produce wind turbine towers, the longer term objective of the company evidently involved plans to build hubs and blades and, eventually, to assemble full-scale nacelles. The second wind turbine tower factory, GRI Towers, was established as a subsidiary of the Spanish company GRI Renewable Industries, a specialised global supplier of towers, flanges, casting components and services for wind turbine projects (GRI, 2017a; GRI, 2017b). The GRI Towers factory started operations in 2014 with a capacity to produce 150 towers per year (Creamer, 2015). The third wind tower factory was established by the Spanish project developer Acciona S.A. as part of a 138-MW wind power project developed by Acciona S.A. entitled the Gouda Wind Farm, which was put into operation in 2015 (Deign, 2016). The factory was located in close vicinity to the power plant. The towers produced by Acciona S.A. differ from those of the other two factories, as they involve the use of concrete rather than bended steel plates as the main building material.

The prevailing vertical conditions in the GVC for wind turbines suggest that the barriers to entry are relatively low for towers compared to blades and nacelle components. The modular governance structure means that the purchase of towers is not complex, the towers are easily codified and the manufacturing competences of the relevant suppliers are generally high in most developing countries (see section 4). These GVC conditions, which are conducive to the local production of towers, were indeed also identifiable in this case. In relation to DCD Wind Towers, the existing skills base in the supply of heavy engineering and related equipment was highly relevant for producing towers according to design specifications received under a licensing agreement with a global first-tier supplier. In the case of GRI Towers, the creation of a local subsidiary by a global first-tier supplier involves a more direct approach to the localisation of wind turbine tower manufacturing. While DCD Wind Towers represents the entry into the wind turbine GVC of an external (local) supplier, the establishment of GRI Towers reflects the localisation strategy of a global first-tier supplier of towers, which involves following their main clients to key strategic markets (GRI, 2017c). This localisation strategy is similar to that of Acciona S.A., which has established local production of towers in relation to the projects it has developed across the world, which typically involves supplying projects on a turnkey basis (ACCIONA, 2017). Whereas the relevant skills and competences were to be found in the domestic industry, the employees in the local tower manufacturers appear to have received some training and supervision through their relationships with the foreign technology providers.

However, there is also an important horizontal element to the establishment of local production of towers. As part of the government’s industrial policy to localise the production of wind turbine components, the IPAPs included the establishment of so-called Special Economic Zones (SEZ). These zones are geographically designated areas in which companies that establish manufacturing facilities qualify for various economic incentives, including reduced rates of corporation tax. GRI Towers and DCD Wind Towers were located in such industrial development zones, respectively in the Atlantis SEZ in the Western Cape (GRI Towers) and in the Coega SEZ near Port Elizabeth (DCD Wind Towers), and were therefore eligible to receive support (GRI, 2017b). Our interviews indicate that the support received by these companies from the SEZ incentives played an instrumental role in attracting manufacturing to these areas (Cloete, 2013). Moreover, the minimum LCR thresholds for project developers put forward under the REIPPPP program were increased from 25% in the first round to 35% in the second round and 40% in the third round. In the first round, according to van der Berg (2013), it was sufficient for project developers to source the balance of plant (BoP) components locally, including civil works, grid connections and logistics, in order to comply with the LCR, as this amounted to around 25% of the total contract value. This meant that higher value turbine components, such as towers and blades, were imported by project developers from overseas suppliers in the first round (Eberhard et al., 2014). However, with the successive increase in the minimum LCR thresholds in the second and third rounds, project developers were required to move beyond relying exclusively on the local sourcing of BoP components, as the costs of doing so would not suffice for compliance. Our interviews suggest that the rise in the LCR thresholds provided a strong incentive for prospective companies to establish the local production of towers and for project developers to source towers from local suppliers (see also DTI, 2015). This meant that lead firms involved as total system suppliers in the wind power projects developed under the REIPPPP program were keen to engage in strategic partnerships with local suppliers of towers in order to comply with the LCR rules. Consequently, DCD Wind Towers and GRI Towers entered into sub-supplier contracting agreements with Vestas, Nordex and Siemens to supply towers to the projects developed by these firms under the REIPPPP program (Baker and Sovacool, 2017). For project developers, the sourcing of locally produced towers provided an opportunity to reduce the overall capital costs of project construction. As shown in Figure 6, this meant that towers were produced locally in the second and third rounds. In the latest, fourth round of the REIPPPP program, adopted in 2014, the minimum LCR threshold wind power projects has remained at 40% and has thus continued to provide an impetus for local tower production.

FIGURE 6. LOCAL CONTENT FOR PREFERRED BIDDERS OF WIND-POWER PROJECTS IN BID ROUNDS 1, 2 AND 3.

Local content indicators	Bid round 1	Bid round 2	Bid round 3
% of project value	27.4%	48.1%	46.9%
Total project value	727 mio.	817 mio.	283 mio.
Components localised	■ Balance of plant components	■ Towers ■ Balance of plant components	■ Towers ■ Balance of plant components ■ Meteorological masts ■ Anchor cages

Source: DTI (2015).

6.2. LOCAL PRODUCTION OF BLADES

Up until now, one wind turbine blade factory has been established in South Africa, and one plant has come close to starting construction. The plant that has already been set up is owned by the South African-based company Isivunguvungu Wind Energy Converter (I-WEC), which started operations in 2011. It produced its first prototype blade in 2012 according to design specifications obtained under a licencing agreement with Aerodyn. The first blade was supplied to a relatively small (2.5 MW) project developed for a local steel supplier, which was intended to serve as a demonstration plant for I-WEC to produce blades for large-scale projects developed from the third round of the REIPPPP program onwards. In 2011, the DCD Group became the majority shareholder in I-WEC and set out a longer term strategy for the company, which involved producing fully operational turbines by manufacturing the blades and towers locally at the DCD Wind Towers factory and establishing a local turbine-assembly plant. The company strategy initially involved importing key nacelle components and sourcing input materials locally, such as steel. Over time, however, the DCD Group aimed at producing nacelle components locally, such as the gearbox, the aim being to produce two hundred turbine units per year (Maritz, 2011). Evidently, as part of the demonstration project, the company managed to manufacture not only an 80m tower, but also a 50m blade, and it also assembled the nacelle for the turbine.

The second wind turbine blade factory that came close to starting construction involved the Danish company LM Wind Power, a global first-tier supplier of blades. The planning for the factory started in 2011, when LM Wind Power signed a cooperation agreement with the Industrial Development Corporation (IDC) to work jointly towards establishing local manufacturing of blades (NAW, 2013). Subsequently, LM Wind Power negotiated with various government agencies and local planning authorities about the conditions for the establishment of the factory. During the negotiations, the plans to establish the factory gradually become more concrete and came close to reaching their final form that would have allowed construction to start (DTI, 2015). However, in 2013, the management of LM Wind Power decided to postpone the plans to establish the factory, which has not yet started construction.

The vertical conditions in the GVC for wind turbines provide some explanation for the establishment and failure to establish the local production of blades in South Africa. As the production of blades is not easy to codify, the complexity of the transactions between buyers and suppliers is relatively high. Moreover, compared to the production of towers, which relies mainly on the available local craftsmanship in the form of steel bending and welding techniques, the production of blades involves a more technically advanced production system, which includes a closely monitored, sensitive, vacuum-based infusion process whereby fibre and chemicals react to create high-quality composite materials. The capabilities in the supply base must therefore be highly advanced and specialised. Consequently, in the case of I-WEC, Aerodyn and key foreign material suppliers undertook a major and prolonged effort to train and supervise factory employees in these operational procedures. However, in spite of these training efforts, our interviews suggest that the blades produced at the I-WEC factory did not live up to Aerodyn's quality requirements, which meant that Aerodyn could not guarantee their performance. This reflects the high requirements and the lack of capabilities in the supply base, which were evidently difficult to circumvent. As a consequence, I-WEC was liquidated in 2013, and the factory was closed shortly afterwards (Eberhard et al., 2014; DTI, 2015).

This history of the two blade factories (established and planned) can be interpreted as reflecting a general pattern in the GVC for wind turbines in which lead firms either produce blades in-house or outsource them to a few highly specialised first-tier global suppliers through close ties. The first-tier blade-suppliers tend to follow their main lead firm customers globally, sometimes by establishing local production if the expected market demand is considered sufficient to justify the investment. This was clearly the case for LW Wind Power, which had already supplied blades to a number of projects developed under the REIPPPP program involving lead firms, such as Vestas and Nordex, as turbine suppliers. The considerations concerning the establishment of a local blade factory therefore seem to have been justified by the interest from prospective customers in light of the future expected market demand and the possibility for lead firms to reduce their costs by localising the production of blades.

There is also a horizontal dimension to establishing the local production of blades. On the one hand, according to our interviews, the economic incentives provided by the IPAPs seem to have motivated the development of the two factories, which were both located within the designated (SEZ) areas. On the other hand, a main impediment to the establishment and continuation of the local production of blades was the minimum threshold levels in the LCR, which in rounds three and four remained at 40%. This meant that is was sufficient for project developers to purchase locally produced towers and BoP components in order to fulfil the LCR's requirements. According to DTI (2015), the minimum LCR threshold level would need to increase to 60% in order to incentivise the local production of blades. Moreover, as part of the REIPPPP program the government set out a target for the annual average installed capacity to be at 677 MW until 2020, after which demand would decrease to 467 MW annually. In our interviews, we found that the necessary market demand needed for companies to justify establishing the local production of blades is in the range of an average annual installed capacity of around 800-1,000 MW (see also DTI, 2015). Consequently, while the market opportunities associated with the REIPPPP program do seem to have contributed to incentivising I-WEC and LM Wind Power to establish the local production of blades, the expected market demand fell short of the required long-term demand. Added to this are the uncertain political signals about future market demand that appeared in political discussions from around 2013 onwards, which did not provide the predictable and long-term planning horizon necessary for investors to proceed with plant investments.

6.3. LOCAL PRODUCTION OF NACELLE COMPONENTS

All the key nacelle components used in the wind-power projects constructed in South Africa under the REIPPPP program, such as the gearboxes, bearings, generators, alternators and casting components, have been imported from abroad, mainly from European suppliers. Hence, to our knowledge, there has not been any attempt to establish the local production or assembly of nacelle components.

Given the unfavourable vertical conditions in the GVC for wind turbines, this situation is not surprising. As mentioned previously, the complexity of transactions for nacelle components is generally high, the requirements for capabilities in the supply base are very high, and the codifiability of transactions varies across the specific components. Compared to towers and blades, nacelle components are less bulky and involve lower transportation costs, therefore they can be transported more easily globally. Hence, as the incentive for lead firms to localise production of these components is lower, nacelle components are often imported directly from in-house facilities or from a limited number of highly specialised global first-tier suppliers in the US, Europe and Asia. These unfavourable vertical conditions were also highlighted during our interviews as having prevented investment in the establishment of local nacelle component production facilities. There is some degree of related competences in the domestic supply base, such as local producers of gearboxes. However, it seems that the high-quality requirements and the complexity of the production process have discouraged local producers from pursuing the establishment of production or assembly of nacelle components (Rycroft, 2012).

The horizontal conditions appear to have been equally disadvantageous in encouraging the local production of nacelle components. As described above, the continuation of the 40% LCR threshold level did not incentivise the local production of components with a higher value than the towers. In addition, the economic incentives provided by the government to localise production in dedicated zones do not seem to have been sufficient to encourage local production given the low costs and ease of transporting and importing these components.

7. DISCUSSION

7.1. THE HORIZONTAL DIMENSION AS A NEW PERSPECTIVE ON THE INSTITUTIONAL CONTEXT

The conventional approach in the GVC literature involves analysing the insertion and upgrading of local suppliers in GVCs according to four basic dimensions: (i) the input-output structure (i.e. the process of transforming raw materials into final products); (ii) the geographical aspect (i.e. the physical localisation of key actors in the chain); (iii) the governance structure (i.e. the role of lead firms in controlling the value chain); and (iv) the institutional context (i.e. the institutional embeddedness of the value chain) (Gereffi, 1995). As noted initially, most empirical studies in the GVC literature focus on the first three (vertical) dimensions, the institutional context often not being analysed in any detail. This means that the notion of the institutional context has generally been left underdeveloped conceptually. To the extent that the institutional context is operationalised analytically in research on GVCs, it is mainly conceptualised as relating to how GVCs are affected by factors operating at a global scale, such as changes in global governance regimes due to multilateral trade agreements. Examples include research on the changing prospects for upgrading in the garment industry due to the adoption of the Multi-Fibre Arrangement (MFA) (Gereffi and Memedovic, 2003), the role of the TRIPS agreement in upgrading local suppliers in the pharmaceuticals industry (Haakonsson, 2009) and the influence of global certification schemes on the environmental performance of local suppliers in the fishing industry (Ponte, 2012). As has been shown in this paper, the concept of the horizontal dimension allows research on the institutional context to move from the global (macro) scale to the national (meso) and the local (micro) scales in order to provide a more fine-grained and context-specific account of the chain-external conditions that may impact on the prospects for insertion and upgrading in GVCs. The focus in this paper on the role of industrial policy as a key aspect of the horizontal dimension in establishing local component production highlights a specific need to devote more attention to the role of states in creating an enabling environment for insertion and upgrading in GVCs as an interesting topic to explore in its own right (Neilson et al., 2014). More broadly, however, the territorial nature of these national policies points to a general need to anchor the analysis of the institutional context more firmly within a narrower spatial boundary that can take into account the political and economic framework conditions that are at work both locally and nationally (Liu, 2016). Following the suggestion in Bolwig et al. (2010), in this paper we have focused on a specific node in the value chain (the production node) and analysed a specific aspect of the horizontal dimension (the role of national policy) operating nationally, which was found to have local implications for industrial development. But in research going forward, it could be relevant to explore a number of additional aspects of the horizontal dimension around various nodes along the value chain in the specific context in question. As proposed by Pietrobelli and Rabellotti (2011), subsequent research on the horizontal dimension could potentially benefit from the innovation system perspective, which focuses on the interplay between actors, networks and institutions pertaining to specific technologies in a national context (Lundvall, 1992). This perspective could, for example, help unravel how the notion of capabilities in the supply base, as a key aspect of the vertical dimension in the GVC framework, is preconditioned by the functioning of the national innovation system in question.

7.2. THE ROLE OF INDUSTRIAL POLICY IN THE CONTEXT OF ECONOMIC GLOBALISATION

The empirical results presented above show the advantages of integrating the vertical and horizontal dimensions in generating a comprehensive account of the critical conditions enabling or not enabling the local production of key wind turbine components in South Africa. Hence, it seems evident that an analysis focusing exclusively on the vertical conditions in the value chain would not have sufficed to generate an adequate account in this case. As shown above, the strategy of the government in promoting the local production of wind turbine components through the industrial policy adopted under the IPAPs, which was incorporated into the REIPPPP program, played a role in incentivising the establishment of local production of wind turbine components, especially with regard to towers. The LCR and the economic incentives provided by the government were particularly important in this respect. These favourable (and sometimes unfavourable) horizontal conditions were both supported and counteracted by the prevailing vertical conditions in the value chain. This finding seems to suggest that it is the exact interplay between and relative importance of the vertical and horizontal dimensions that is significant for the insertion and upgrading of local suppliers in GVCs. The paper thus raises a broader question about the role of industrial policy in supporting local industrial development. While LCRs have been widely used as a key policy instrument to support industry development, as repeatedly stressed in the infant industry literature during the 1980s and 1990s (Wade, 1988), there is widespread recognition that the basic conditions for catching up have changed significantly since (Gereffi, 2014). In particular, as argued by Wade (2003), the ability of governments to promote the development of domestic industries has been reduced significantly because of the adoption of the WTO regulation prohibiting the use of LCRs. However, this paper shows that the use of LCR is still a feasible policy instrument for governments to stimulate local industrial development, which questions the circumstances under which such measures are tolerated by the WTO (Natsuda and Thoburn, 2014). LCRs have also been used widely in renewable energy policies similar to the REIPPPP program that have been adopted globally in order to support local industrial development (IRENA, 2013). However, as LCRs have generated mixed results in establishing local production, this would seem to suggest that their use is not a generic one-size-fits-all policy instrument guaranteed to generate the desired results (Rennkamp and Boyd, 2015). The effects of the requirements for local content also seem to depend on the specific configuration of the LCR in various countries and how it is combined with other supportive policy measures (UNCTAD, 2014). In any case, as shown in this paper, the increasing organisation of global industries in GVCs points to the need to incorporate considerations concerning the specific GVC in question in the process of designing and implementing policies to support local industry development. This in turn points to a need for an exhaustive understanding of the specific GVC in order to tailor policies to the specific technology and industry and thus enhance their effectiveness (Gereffi, 2014).

8. CONCLUSION

This paper began by highlighting the dominant focus in the GVC literature on the role of the internal conditions of GVCs that influence the barriers to entry for local suppliers. This prevailing focus on the vertical dimension largely overlooks the chain-external conditions that might be of equal importance in determining the prospects for the insertion and upgrading of local suppliers in GVCs. To contribute to filling this knowledge gap, in this paper we have focused on analysing the role of industrial policy as a key horizontal dimension pertaining to the establishment of the local production of wind turbine components in South Africa. We drew on insights from the infant industry literature to focus attention on the role of the state and of national policy in enabling local industry development, which was combined with a conventional GVC analysis focusing on the vertical dimension. We find that, overall, the establishment of local production of key wind turbine components has only made relatively limited progress so far in South Africa, which is due to the specific combination of vertical and horizontal dimensions in relation to the specific components in question.

Local production of towers has generally progressed furthest compared to the manufacture of blades and nacelle components in terms of the number and longevity of the created local production facilities. The vertical conditions in the value chain were generally encouraging for the local production of towers due to the low barriers to entry arising from the high level of capabilities in the domestic supply base and the high codifiability and low complexity of transactions. The establishment of the local production of towers also reflects the typical procedure of first-tier suppliers of towers in localising production in their key markets globally either directly or through a local licensing partner, for example. The horizontal conditions were also conducive to the establishment of the local production of towers. This was mainly related to the economic incentives the government provided to localise manufacturing and, in particular, the gradual increase in the minimum LCR threshold levels.

The vertical conditions in the value chain were unfavourable for the establishment of local production of blades, which requires highly specialised capabilities in the supply base and which is characterised by the high complexity and low codifiability of transactions. However, in spite of the high barriers to entry for new entrants, one blade-manufacturing plant was established by a local company, and a second plant developed by a foreign first-tier blade-supplier came close to starting construction. As in the case of the towers, both cases reflect the distinctive strategy adopted by global first-tier suppliers of blades to follow their main clients globally by setting up local production directly or indirectly through local partners. The closure of the plant developed by the domestic company reflects the high quality requirements and the consequent need for highly specialised capabilities and expertise that is difficult to build in a short timeframe. The horizontal dimensions were also discouraging for the local production of blades, as the REIPPPP program was not able to create sufficient long-term market demand. Moreover, as the minimum LCR threshold remained at 40%, it was sufficient for project developers to source locally produced towers and balance of plant components to fulfil these requirements.

Local production of nacelle components has not materialised or even been attempted in South Africa. This is not surprising given the very discouraging vertical conditions in the value chain, characterised by highly complex transitions, requirements for highly specialised skills in the supply base and components that differ in codifiability. As nacelle components are small compared to towers and blades, they can be transported globally relatively easy and at low cost, which means that lead firms do not have an incentive to establish local production of nacelle components. The horizontal conditions were equally discouraging in this regard given the levelling out of the minimum LCR threshold level and the insufficient economic incentives provided by the government.

This paper should be considered as a first and explorative attempt at conducting a systematic analysis of the relative significance of the vertical and horizontal dimensions for the insertion and upgrading of local suppliers in GVCs. The findings presented point out the limitations in the use of LCRs as the main policy instrument used to promote the development of domestic industries (Rennkamp and Boyd, 2015). Hence, the use of LCRs may more appropriately be considered as one element in a broader package of dedicated policy instruments to support domestic companies in achieving insertion into GVCs. Such a package could include dedicated investments in developing the domestic skills base through training and educational programs and by providing publicly funded R&D in the selected technologies. As highlighted in the paper, such a technology-sensitive approach would require becoming familiar with the structure and organisation of the global value chain in question in order to tailor the policies according to the specific industry (Binz et al., 2017).

The findings presented here generally confirm the prediction of Schmitz and Huenteler (2016) that the local manufacture of key wind-turbine components in South Africa and other high-income developing countries can only be expected for components that are bulky and difficult or costly to transport, such as towers and blades. However, this pattern of the establishment of local component manufacturing could be very different in relation to other technologies, such as solar photovoltaic, for example, which comprises components that are all relatively small, low in cost and easily transported, such as solar panels and inverters. Hence, for purposes of comparison, it would be interesting in future research to analyse the relative importance of the vertical and horizontal dimensions for the insertion and upgrading of local suppliers in such industries.

REFERENCES AND ANNEX

REFERENCES

ACCIONA (2017) South Africa. ACCIONA, accessed at https://www.acciona.com/in-the-world/africa/south-africa/, May 2, 2017.

Altenburg, T. (2011) Industrial policy in developing countries: overview and lessons from seven country cases. German Development Institute, Discussion Paper (4), Bonn.

Altman, M. and Mayer, M. (2003) 'Overview of Industrial Policy'. In Kraak, A. and Perold, H. (eds.) Human Resources Development Review 2003: education, employment and skills in South Africa. HSRC Press, Cape Town.

Amsden, A. (1989). Asia's Next Giant: South Korea and Late Industrialization. New York: Oxford University Press.

Andersen, P. and Larsen, T. (2013) Establishing Internationally Competitive Wind Turbine Component Production in South Africa: A Feasibility Study. Master's Thesis, Copenhagen Business School.

Babb, S. (2013) 'The Washington Consensus as transnational policy paradigm: its origins, trajectory and likely successor'. Review of International Political Economy, 20(2), 268-297.

Baker, L. (2016) 'Technology Development in South Africa: The Case of Wind and Solar PV'. Working Paper, SPRU Series; accessed at https://www.sussex.ac.uk/webteam/gateway/file.php?name=2016-05-swps-baker.pdf&site=25, 18 May 2017.

Baker, L. and Sovacool, B. (2017) 'The political economy of technological capabilities and global production networks in South Africa's wind and solar photovoltaic (PV) industries'. Political Geography, 60, 1-12.

Bell, M. and Pavitt, K. (1995) 'The development of technological capabilities'. Trade, Technology, and International Competitiveness, 22(4831), 69-101.

Binz, C., Gosens, J., Hansen, T. and Hansen, U. (2017) ' Toward Technology-Sensitive Catching-Up Policies: Insights from Renewable Energy in China'. World Development (in press): http://dx.doi.org/10.1016/j.worlddev.2017.03.027

Blanco, M. (2009). 'The economics of wind energy'. Renewable and Sustainable Energy Reviews, 13(6), 1372-1382.

Blankley, W. and Booyens, I. (2010) 'Building a knowledge economy in South Africa'. South African Journal of Science, 106(11/12), 1-6.

Bolwig, S., Ponte, S., du Toit, A., Riisgaard, L. and Halberg, N. (2010) 'Integrating Poverty and Environmental Concerns into Value-Chain Analysis: A Conceptual Framework'. Development Policy Review, 28(2), 173-194.

Bretton Woods Project (2012) 'The World Bank and industrial policy: hands off or hands on?' The Bretton Woods Update, 83, accessed at: http://www.brettonwoodsproject.org/2012/12/art-571554/, May 1, 2017.

Brodsky, S. and Matarirano, G. (2015) South Africa's Renewable Energy Programme: An African success story. Macfarlanes, London. accessed at http://www.macfarlanes.com/media/452954/south-africas-renewable-energy-programme-an-african-success-story-jan-2015_website.pdf, May 2 2017].

BTM Consult (2011) International wind energy development: supply chain assessment 2012-2015. BTM Consult (Navigant, Inc.)

BTM Consult (2013) World market update 2012: international wind energy development, forecast 2013-2017. Copenhagen: BTM Consult (Navigant, Inc.).

Cimoli, M., Dosi, G., and Stiglitz, J. (2009). Industrial policy and development: the political economy of capabilities accumulation. Oxford: Oxford University Press.

Cloete, K. (2013) Suppliers seek clarity on future REIPPPP local-content requirements, accessed at http://www.polity.org.za/article/suppliers-seek-clarity-on-future-reipppp-local-content-requirements-2013-09-26, May 2, 2017.

Creamer, T. (2015) Locally made wind-turbine tower sections set off from Atlantis factory. Engineering News, accessed at http://www.engineeringnews.co.za/article/locally-made-wind-turbine-tower-sections-set-off-from-atlantis-factory-2015-10-19/rep_id:4136, May 2, 2017.

Curran, L. (2015) 'The impact of trade policy on global production networks: the solar panel case.' Review of International Political Economy, 22(5), 1025-1054.

DE (2010) Integrated Resource Plan for Electricity. Department of Energy, Republic of South Africa. accessed at http://www.energy.gov.za/IRP/irp% 20files/INTEGRATED_RESOURCE_PLAN_ELECTRICITY_2010_v8.pdf, May 2, 2017.

Deign, J. (2016) South Africa eyes first blade factory to boost local content. Wind Energy Update, accessed at http://analysis.windenergyupdate.com/emerging-markets/south-africa-eyes-first-blade-factory-boost-local-content, May 2, 2017.

Department of Energy (2012) General requirements, rules and provisions. Request for qualification and proposals for new generation capacity under the IPP procurement programme. (Updated version ed.) Department of Energy, Republic of South Africa, accessed at https://irp2.files.wordpress.com/2012/07/small-projects-rfp-part-a-general-requirements-rules-pdf-2012-06-14_f1.pdf, May 2, 2017.

DME (2003) White Paper on Renewable Energy. Department of Minerals and Energy, Republic of South Africa, accessed at https://unfccc.int/files/meetings/seminar/application/pdf/sem_sup1_south_africa.pdf, May 2, 2017.

DTI (2010) Wind Power for Local Economic Development: South Africa leading the way. Department of Trade and Industry (DTI), Republic of South Africa, accessed at http://www.energy.gov.za/files/SAWEP/DTI_GerhardFourie.ppsx, May 2, 2017.

DTI (2013a) DTI Strategy on renewable Energy industry Development: Africa Renewable Energy Dialogue. Department of Trade and Industry (DTI), Republic of South Africa, accessed at http://area-net.org/wp-content/uploads/2016/01/Ntombifuthi-Ntuli_DTI_South_Africa.pdf, May 2, 2017.

DTI (2013b) Localisation and Investment Promotion for Renewable Energy. Department of Trade and Industry (DTI), Republic of South Africa, accessed at http://www.dedea.gov.za/Presentations/Provincial%20Renewable%20Energy%20Forum%20Presentations/Provincial%20Sustainable%20Energy%20Forum%20Meeting%20-%200313/20130307%20Ntombifuthi%20Ntuli%20Enegy%20Forum%20East%20London.pdf, May 2, 2017.

DTI (2015) The wind energy industry localisation roadmap in support of large-scale roll-out in South Africa. Prepared by Urban-Econ Development Economists. Department of Trade and Industry, Republic of South Africa, accessed at http://www.wasaproject.info/docs/WindEnergyLocalisationStudyJan2015.pdf, May 2, 2017.

Eberhard, A., Kolker, J. and Leigland, J. (2014) South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons. World Bank Group, Washington, accessed at http://www.gsb.uct.ac.za/files/PPIAFReport.pdf, May 2, 2017.

Elola, A., Parrilli, M. and Rabellotti, R. (2012) 'The Resilience of Clusters in the Context of Increasing Globalization: The Basque Wind Energy Value Chain'. European Planning Studies, 21(7), 989-1006.

Freeman, C. (1988). 'Japan: a new national innovation system. Technology and economy theory'. In G. Dosi, C. Freeman, R. Nelson, G. Silverberg and L. Soete (eds.) Technical Change and Economic Theory, London: Pinter, pp. 331–348.

Garud, R. and Karnøe, P. (2003) 'Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship'. Research Policy, 32(2), 277–300.

Gereffi, G. (1994) 'The Organisation of Buyer-driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks', in G. Gereffi and M. Korzeniewicz (eds.) Commodity Chains and Global Capitalism, Westport, CT: Praeger, pp. 95–122.

Gereffi, G. (1995) 'Global Production Systems and Third World Development'. In B. Stallings (ed.), Global Change, Regional Response: The New International Context of Development. Cambridge, New York and Melbourne: Cambridge University Press, pp. 100-142.

Gereffi, G. (1999) 'International Trade and Industrial Upgrading in the Apparel Commodity Chain', Journal of International Economics, 48, 37–70.

Gereffi, G. (2001). 'Beyond the producer-driven/ buyer-driven dichotomy: The evolution of global value chains in the internet era'. IDS Bulletin, 32(3), 30-40.

Gereffi, G. and Memedovic, O. (2003) The Global Apparel Value Chain: What Prospects for Upgrading by Developing Countries? United Nations Industrial Development Organization (UNIDO), Vienna, accessed at http://www.ids.ac.uk/ids/global/pdfs/AppareF1.pdf, May 2, 2017.

Gereffi, G., Humphrey, J., and Sturgeon, T. (2005). 'The governance of global value chains'. Review of International Political Economy, 12(1), 78-104.

Gereffi, G. (2014) 'A global value chain perspective on industrial policy and development in emerging markets', Duke Journal of Comparative & International Law, 4, 433-458.

Gibbon, P. and Ponte, S. (2005) Trading Down: Africa, Value Chains, and the Global Economy, Temple University Press, Philadelphia.

Grant Thornton (2012) Capturing opportunity: cleantech business booms around the world, accessed at http://www.gt.co.rs/Publications/Studije/ibr2012-capturing_opportunity.pdf, May 2, 2017.

GRI (2017a) Business Lines. GRI Renewable Industries, accessed at http://www.gri.com.es/en/company/business/, May 2, 2017.

GRI (2017b) Big step into wind power. GRI Renewable Industries, accessed at http://www.gri.com.es/en/big-step-into-wind-power/, May 2, 2017.

GRI (2017c) GRI Towers. GRI Renewable Industries, accessed at http://www.gri.com.es/en/company/business/gri-towers/, May 2, 2017.

GWEC (2016) Global Wind Statistics. Global Wind Energy Council (GWEC), accessed at http://www.gwec.net/wp-content/uploads/vip/GWEC-PRstats-2015_LR.pdf, May 2, 2017.

Haakonsson, S. (2009) 'Learning by importing` in global value chains: upgrading and South–South strategies in the Ugandan pharmaceutical industry'. Development Southern Africa, 26(3), 499-516.

Hobday, M. (1995) 'East Asian latecomer firms: learning the technology of electronics.' World Development, 23(7), 1171-1193.

Hobday, M. (1998) 'Product complexity, innovation and industrial organisation'. Research Policy, 26(6), 689–710.

Huenteler, J., Schmidt, T., Ossenbrink, J., Hoffmann, V. (2016) 'Technology life-cycles in the energy sector: technological characteristics and the role of deployment for innovation'. Technological Forecasting & Social Change, 104, 102–121.

Humphrey, J., and Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? Regional Studies, 36(9), 1017-1027.

IEA (2013) Technology Roadmap: wind energy. Paris, International Energy Agency (IEA), accessed at https://www.iea.org/publications/freepublications/publication/Wind_2013_Roadmap.pdf, May 2, 2017.

IPAP (2013) Industrial Policy Action Plan 2013/14-2015/16, South Africa, accessed at http://www.thedti.gov.za/news2013/ipap_2013-2016.pdf, May 2, 2017.

IRENA (2013) 'Renewable Energy Auctions in Developing Countries'. The International Renewable Energy Agency (IRENA), accessed at https://www.irena.org/DocumentDownloads/Publications/IRENA_Renewable_energy_auctions_in_developing_countries.pdf, May 17, 2017.

Kaplinsky, R. (2000). Globalisation and unequalisation: what can be learned from value chain analysis? The Journal of Development Studies, 37(2), 117-146.

Kaplinsky, R. and Morris, M. (2003): A Handbook for Value Chain Research. Institute of Development Studies, University of Sussex.

Kim, L. (1997) Imitation to Innovation: The Dynamics of Korea's Technological Learning. Harvard Business School Press, Boston.

Kim, L., and R. Nelson, 2000 Technology, Learning, and Innovation. Cambridge: Cambridge University Press.

Kirkegaard, J. , Hanemann, T., and Weischer, L. (2009). It should be a breeze: harnessing the potential of open trade and investment flows in the wind energy industry. World Resources Institute, December.

Lema, R., Berger, A., Schmitz, H. and Song, H. (2011) Competition and Cooperation between Europe and China in the Wind Power Sector. Institute of Development Studies, Working Paper (377), Brighton.

Lema, R., and Lema, A. (2012). 'Technology transfer? The rise of China and India in green technology sectors.' Innovation and Development, 2(1), 23-44.

Lema, R. and Rabelotti, R. (2016) 'Innovation Systems in the Era of Global Value Chains'. European Journal of Development Research, Special Issue, Call for papers.

Lewis, J. (2011) 'Building a national wind turbine industry: experiences from China, India and South Korea'. International Journal of Technology and Globalisation, 5(3-4), 281–305.

Lewis, J., and Wiser, R. (2005). Fostering a renewable energy technology industry: an international comparison of wind industry policy support mechanisms. Ernest Orlando Lawrence Berkeley National Laboratory.

Liu, Y. (2016) 'The dynamics of local upgrading in globalizing latecomer regions: a geographical analysis'. Regional Studies, 1-14. http://dx.doi.org/10.1080/00343404.2016.1143924

Lundvall, B.-Å., ed. (1992) National systems of innovation: Toward a theory of innovation and interactive learning. Pinter Publishers, London.

Maritz, J. (2011) SA's first wind turbine manufacturer hearing up for production. How We Made It In Africa, accessed at https://www.howwemadeitinafrica.com/sas-first-wind-turbine-manufacturer-gearing-up-for-production/, May 2, 2017.

Mathews, J. and Cho, D. (1999) 'Combinative capabilities and organizational learning by latecomer firms: the case of the Korean semiconductor industry.' Journal of World Business, 34 (2), 139-156.

Meijer, P., Verloop, N. and Beijaard, D. (2002) 'Multi-Method Triangulation in a Qualitative Study on Teachers' Practical Knowledge: An Attempt to Increase Internal Validity'. Quality & Quantity, 36: 145-167.

Milberg, W., Jiang, X. and Gereffi, G. (2011) 'Industrial policy in the era of vertically specialized industrialization'. In Salazar-Xirinachs, J., Nübler, I. and Kozul-Wright, R. (eds.) Transforming economies: making industrial policy work for growth, jobs and development. International Labour Office, Geneva.

Miles, M. and Huberman, M. (1994) Qualitative Data Analysis: An Expanded Sourcebook. SAGE Publications, New Delhi.

Morris, M., Staritz, C. and Barnes, J. (2011). 'Value chain dynamics, local embeddedness, and upgrading in the clothing sectors of Lesotho and Swaziland.' International Journal of Technological Learning, Innovation and Development, 4(1), 96-119.

Morrison, A., Pietrobelli, C., and Rabellotti, R. (2008) 'Global value chains and technological capabilities: a framework to study learning and innovation in developing countries.' Oxford Development Studies, 36(1), 39–58.

Natsuda, K. and Thoburn, J. (2014) 'How much policy space still exists under the WTO? A comparative study of the automotive industry in Thailand and Malaysia.' Review of International Political Economy, 21(6), 1346-1377.

Navas-Alemán, L. (2010) 'The impact of operating in multiple value chains for upgrading: the case of the Brazilian furniture and footwear industries.' World Development, 39, 1386–1397.

NAW (2013) 'Blade Manufacturer LM Wind Power to Expand Into South Africa.' North American Windpower (NAW), accessed at http://nawindpower.com/blade-manufacturer-lm-wind-power-to-expand-into-south-africa, May 2, 2017.

Neilson, J., Pritchard, B. and Yeung, H. (2014) 'Global value chains and global production networks in the changing international political economy: an introduction.' Review of International Political Economy, 21(1), 1-8.

Pietrobelli, C. and Rabelotti, R. (2011) 'Global Value Chains Meet Innovation Systems: Are There Learning Opportunities for Developing Countries?' World Development, 39(7), 1261-1269.

Ponte, S. and Ewert, J. (2009) 'Which Way is "Up" in Upgrading? Trajectories of Change in the Value Chain for South African Wine.' World Development, 37(10), 1637-1650.

Ponte, S. (2012) 'The Marine Stewardship Council (MSC) and the Making of a Market for "Sustainable Fish"'. Journal of Agrarian Change, 12(2-3), 300-315.

Rennkamp, B. and Westin, F. (2013). Feito no Brasil? Made in South Africa? Boosting technological development through local content requirements in the wind energy industry. Energy Research Centre, University of Cape Town and Environmental Science Laboratory – LIMA, Federal University of Rio de Janeiro.

Rennkamp, B. and Boyd, A. (2015) 'Technological capability and transfer for achieving South Africa's development goals'. Climate Policy, 15(1), 12-29.

Rycroft, M. (2012) Interview with Thomas Schaal, I-WEC. Sustainable Energy, accessed at *http://www.ee.co.za/wp-content/uploads/legacy/energize_2012/09_ST_03_Interview.pdf*, May 2, 2017.

Schmidt, T. and Huenteler, J. (2016) 'Anticipating industry localization effects of clean technology deployment policies in developing countries'. Global Environmental Change, 38, 8–20.

UNCTAD (2013) World Investment Report 2013. Global Value Chains: Investment and Trade for Development. United Nations Conference on Trade and Development (UNCTAD).

UNCTAD (2014) Local Content Requirements and The Green Economy. United Nations Conference on Trade and Development (UNCTAD), accessed at *http://unctad.org/en/PublicationsLibrary/ditcted2013d7_en.pdf*, May 2, 2017.

Van den Berg, J. (2013) 'South Africa as a case study of local content and wind power'. Presentation given by the CEO of the South African Wind Energy Association (SAWEA) at the 8th Wind Energy and Development Dialogue, Berlin, October, 2013, accessed at: *https://www.vdma.org/documents/105628/1126748/Presentation_van_den_Berg_SAWEA/21b7da02-b39a-49bf-aaa2-de0856f55e45*, May 18, 2017.

Wade, R. (1988). 'The role of government in overcoming market failure: Taiwan, Republic of Korea and Japan', In H. Hughes (ed.) Achieving Industrialization in East Asia, Cambridge: Cambridge University Press, pp. 129-63.

Wade, R. (1990) Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization. Princeton and Oxford: Princeton University Press.

Wade, R. (2003) 'What strategies are viable for developing countries today? The world trade organization and the shrinking of "development space"'. Review of International Political Economy, 10(4), 621-644.

Wind Power (2017) The Wind Power Wind Energy Market Intelligence, accessed at *http://www.thewindpower.net/country_en_58_south-africa.php*, May 2, 2017.

Yeung, H. (2016). Cornell University Press.

APPENDIX A

List of interviewees:

Interviewee	Affiliation	Title
#1	BTM Consult	Managing Consultant
#2	Department of Trade and Industry, South Africa	Chief Director of Green Industries
#3	South African Wind Energy Association (SAWEA)	CEO
#4	Globeleq / SAWEA	Managing Director / Chair of Policy and Legislation
#5	Stellenbosch University / SAWEA	Director of the Renewable and Sustainable Energy Studies / Chair of Skills Development
#6	Embassy of Denmark in South Africa	Senior Trade Officer
#7	LM Wind Power	Director, Commercial UK & Business Development
#8	Energy Research Center, University of Cape Town.	Researcher

UNEP DTU PARTNERSHIP

VERTICAL AND HORIZONTAL DIMENSIONS OF UPGRADING IN GLOBAL VALUE CHAINS:

THE ESTABLISHMENT OF LOCAL WIND TURBINE COMPONENT MANUFACTURING IN SOUTH AFRICA